FORM PTO-1390 (REV. 5-93)	US DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER 10191/2045

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

US APPLICATION NO. (If known, see 37 CFR 1.5)

10/030888

INTERNATIONAL APPLICATION NO. PCT/DE00/01322	INTERNATIONAL FILING DATE (27.04.00)) 27 April 2000	PRIORITY DATE(S) CLAIMED (07.05.99) 7 May 1999 (22.03.00) 22 March 2000

TITLE OF INVENTION

DEVICE AND METHOD FOR CONTROLLING AN INTERNAL COMBUSTION ENGINE HAVING AN EXHAUST TREATMENT SYSTEM

APPLICANT(S) FOR DO/EO/US
Markus LEUZ, Andreas PFAEFFLE and Ralf SCHERNEWSKI

Applicant(s) herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information

1. ☒   This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.

2. ☐   This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U S C 371.

3. ☒   This is an express request to begin national examination procedures (35 U.S.C. 371(f)) immediately rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).

4. ☒   A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date

5. ☒   A copy of the International Application as filed (35 U.S.C. 371(c)(2))

   a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau)

   b. ☒ has been transmitted by the International Bureau.

   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US)

6. ☒   A translation of the International Application into English (35 U.S.C 371(c)(2)).

7. ☒   Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C 371(c)(3))

   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).

   b. ☐ have been transmitted by the International Bureau

   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.

   d. ☒ have not been made and will not be made.

8. ☐   A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3))

9. ☒   An oath or declaration of the inventor(s) (35 U S C 371(c)(4)) (unsigned)

10. ☒   A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S C 371(c)(5))

Items 11. to 16. below concern other document(s) or information included:

11. ☒   An Information Disclosure Statement under 37 CFR 1 97 and 1.98.

12. ☐   An assignment document for recording   A separate cover sheet in compliance with 37 CFR 3.28 and 3 31 is included.

13. ☒   A **FIRST** preliminary amendment.

☐   A **SECOND** or **SUBSEQUENT** preliminary amendment

14. ☒   A substitute specification and a marked up version thereof.

15. ☐   A change of power of attorney and/or address letter

16. ☒   Other items or information: International Search Report, International Preliminary Examination Report and Form PCT/RO/101

Express Mail No. EV 003624464US

NY01 416842 v 1

U.S. APPLICATION NO. if known, see 37 C.F.R.1.5 10/030888	INTERNATIONAL APPLICATION NO PCT/DE00/01322	ATTORNEY'S DOCKET NUMBER 10191/2045

17. ☒   The following fees are submitted:

	CALCULATIONS	PTO USE ONLY

Basic National Fee (37 CFR 1.492(a)(1)-(5)):
Search Report has been prepared by the EPO or JPO $890.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) . . . $710 00

No international preliminary examination fee paid to USPTO (37 CFR 1.482) but international search fee paid to USPTO (37 CFR 1 445(a)(2)) $740 00

Neither international preliminary examination fee (37 CFR 1 482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO $1,040.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) and all claims satisfied provisions of PCT Article 33(2)-(4) $100.00

ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 890	

Surcharge of $130.00 for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1 492(e)). → $

Claims	Number Filed	Number Extra	Rate		
Total Claims	9 - 20 =	0	X $18 00	$ 0	
Independent Claims	2 - 3 =	0	X $84.00	$ 0	
Multiple dependent claim(s) (if applicable)			+ $280.00	$ 0	

TOTAL OF ABOVE CALCULATIONS =	$ 890	

Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity statement must also be filed. (Note 37 CFR 1 9, 1.27, 1.28) → $

SUBTOTAL =	$ 890	

Processing fee of $130 00 for furnishing the English translation later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1 492(f)).   + → $

TOTAL NATIONAL FEE =	$ 890	

Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3 28, 3.31). $40 00 per property   + → $

TOTAL FEES ENCLOSED =	$ 890	

	Amount to be refunded	$
	charged	$

a. ☐   A check in the amount of $_____ to cover the above fees is enclosed.

b. ☒   Please charge my Deposit Account No. __11-0600__ in the amount of $890 00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒   The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. __11-0600__. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1 494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Kenyon & Kenyon
One Broadway
New York, New York 10004
CUSTOMER NO. 26646

SIGNATURE

Richard L Mayer, Reg. No. 22,490
NAME

11/7/01
DATE

NY01 416842 v 1

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Inventor(s)   :   Markus LEUZ et al.

Serial No.   :   To Be Assigned

Filed   :   Herewith

For   :   DEVICE AND METHOD FOR CONTROLLING AN
                        INTERNAL COMBUSTION ENGINE HAVING AN
                        EXHAUST TREATMENT SYSTEM

Examiner   :   To Be Assigned

Art Unit   :   To Be Assigned

Assistant Commissioner for Patents
Washington, D.C. 20231

PRELIMINARY AMENDMENT

SIR:

Kindly amend the above-identified application before examination, as set forth below.

IN THE SPECIFICATION AND ABSTRACT:

In accordance with 37 C.F.R. § 1.121(b)(3), a Substitute Specification (including the Abstract, but without claims) accompanies this response. It is respectfully requested that the Substitute Specification (including Abstract) be entered to replace the Specification of record.

IN THE CLAIMS:

On the first page of claims, first line, change "What is claimed is" to --WHAT IS CLAIMED IS:--.

Please cancel, without prejudice, claims 1 to 9 in the underlying PCT application. Please also cancel, without prejudice, claims 1 to 7 in the annex to the International Preliminary Examination Report.

NY01 416856 v 2

Please add the following new claims:

--8.   (New) A method for controlling an internal combustion engine having an exhaust treatment system that includes a particle filter, comprising the step of:

simulating a quantity characterizing a state congestion of the particle filter in accordance with at least one operating parameter of the internal combustion engine.

9.   (New) The method according to claim 8, wherein the at least one operating parameter includes at least one of a rotational speed and a signal characterizing an injected fuel volume.

10.   (New) The method according to claim 9, wherein the at least one operating parameter includes an oxygen concentration in the exhaust gas.

11.   (New) The method according to claim 10, further comprising the step of determining the oxygen concentration in the exhaust gas in accordance with operating parameters.

12.   (New) The method according to claim 8, wherein the at least one operating parameter includes a temperature in the exhaust treatment system.

13.   (New) The method according to claim 8, further comprising the step of controlling the exhaust treatment system during a normal operation in accordance with the quantity.

14.   (New) The method according to claim 8, further comprising the step of detecting an error in accordance with the quantity.

15.   (New) The method according to claim 8, further comprising the step of controlling the exhaust treatment system during an emergency operation in accordance with the quantity.

16.   (New) A device for controlling an internal combustion engine having an exhaust treatment system including a particle filter, comprising:
a unit configured to determine a quantity characterizing a state of congestion of the particle filter in accordance with at least one operating parameter of the internal combustion engine.-- .

REMARKS

This Preliminary Amendment cancels, without prejudice, claims 1 to 9 in the underlying PCT Application No. PCT/DE00/01322. This Preliminary Amendment further cancels, without prejudice, claims 1 to 7 in the annex to the International Preliminary Examination Report and adds new claims 8 to 16. The new claims, _inter alia_, conform the claims to U.S. Patent and Trademark Office rules and does not add any new matter to the application.

In accordance with 37 C.F.R. § 1.121(b)(3), the Substitute Specification (including the Abstract, but without the claims) contains no new matter. The amendments reflected in the Substitute Specification (including Abstract) are to conform the Specification and Abstract to U.S. Patent and Trademark Office rules or to correct informalities. As required by 37 C.F.R. §§ 1.121(b)(3)(iii) and 1.125(b)(2), a Marked Up Version of the Substitute Specification comparing the Specification of record and the Substitute Specification also accompanies this Preliminary Amendment. Approval and

entry of the Substitute Specification (including Abstract) is respectfully requested.

The underlying PCT Application No. PCT/DE00/01322 includes an International Search Report dated September 6, 2000, a copy of which is included. The Search Report includes a list of documents that were considered in the underlying PCT application.

The underlying PCT Application No. PCT/DE00/01322 also includes an International Preliminary Examination Report, dated May 11, 2001. A translation of the International Preliminary Examination Report and annex thereto is included herewith.

It is respectfully submitted that the subject matter of the present application is new, non-obvious, and useful. Prompt consideration and allowance of the application are respectfully requested.

Respectfully submitted,

Dated: 11/7/01

By: Richard L. Mayer
Reg. No. 22,490

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DEVICE AND METHOD FOR CONTROLLING AN INTERNAL COMBUSTION ENGINE HAVING AN EXHAUST TREATMENT SYSTEM

FIELD OF THE INVENTION

The present invention relates to a method and a device for controlling an internal combustion engine having an exhaust treatment system.

5

BACKGROUND INFORMATION

A method and a device for controlling an internal combustion engine having an exhaust treatment system is described in German Published Patent Application No. 199 06 287. The system

10   described in this document uses a particle filter that filters out particles contained in the exhaust gas. To precisely control an internal combustion engine having an exhaust treatment system, the status of the exhaust treatment system must be known. In particular, the filter's state of

15   congestion, i.e., the volume of filtered-out particles, must be known.

It is an object of the present invention to provide a method and a device that can be used to detect the status of the

20   exhaust treatment system. In particular, the state of congestion must be detected even when different sensors fail or when no special sensors are used.

SUMMARY

25   The method according to the present invention provides for the detection of the status of the exhaust treatment system. Simulating a quantity that characterizes the status of the exhaust treatment system, based on at least one operating parameter of the internal combustion engine, eliminates the

30   need for additional sensors. If additional sensors are used, they may be monitored and an emergency mode may be implemented. Quantities may be used for the simulation that

are already being used to control the internal combustion engine.

A quantity that characterizes the oxygen concentration in the exhaust gas may also be used. This can significantly improve the simulation of the status of the exhaust treatment system. This applies, for example, to dynamic states, i.e., more accurate values can be achieved, particularly during acceleration.

BRIEF DESCRIPTION OF THE DRAWINGS
Figure 1 is a block diagram of the device according to the present invention.

Figure 2 is a block diagram for detecting the state of congestion according to the present invention.

Figure 3 illustrates a characteristic curve.

Figure 4 is a block diagram of an example embodiment of the device according to the present invention.

DETAILED DESCRIPTION
The device according to the present invention is described below, based on an example of an internal combustion engine having spontaneous ignition in which fuel metering is controlled by a common-rail system. However, the present invention is not limited to these systems. It may also be used with other internal combustion engines.

An internal combustion engine 100 receives a supply of fresh air via an intake line 102 and discharges exhaust gases via an exhaust line 104. An exhaust treatment unit 110, from which the cleaned exhaust gases pass through line 106 to the environment, is provided in exhaust line 104. Exhaust treatment unit 110 includes a primary catalytic converter 112 and a downstream filter 114. A temperature sensor 124, which

provides a temperature signal T, may be located between
primary catalytic converter 112 and filter 114. Sensors 120a
and 120b are provided upstream from primary catalytic
converter 112 and downstream from filter 114, respectively.

5   These sensors act as differential-pressure sensors 120 and
provide a differential-pressure signal DP, which characterizes
the differential pressure between the inlet and outlet of the
exhaust treatment unit.

10   A sensor 125 may be provided to supply a signal characterizing
the oxygen concentration in the exhaust gas. This quantity
may be calculated on the basis of other measured values or be
determined by a simulation.

15   Fuel is supplied to internal combustion engine 100 via a fuel
metering unit 140. This unit meters fuel to the individual
cylinders of internal combustion engine 100 via injectors 141,
142, 143 and 144. The fuel metering unit may be a common rail
system. A high-pressure pump delivers fuel to an accumulator.

20   The fuel passes from the accumulator to the internal
combustion engine via the injectors.

        Various sensors 151, which provide signals that characterize
the status of the fuel metering unit, are attached to fuel

25   metering unit 140. In the case of a common rail system, these
signals may include, for example, a pressure P in the
accumulator. Sensors 152 that characterize the status of the
internal combustion engine are attached to internal combustion
engine 100. These sensors may include a speed sensor that

30   provides a speed signal N and additional sensors that are not
illustrated.

        The output signals from these sensors are supplied to a
control system 130, which is represented by a first control

35   subsystem 132 and a second control subsystem 134. The two
control subsystems may form a single structural unit. First
control subsystem 132 may control fuel metering unit 140 via

control signals AD, which influence fuel metering. For this
purpose, first control subsystem 132 includes a fuel volume
controller 136. The fuel volume controller 136 supplies a
signal ME, which characterizes the volume to be injected, to
5   second control subsystem 134.

Second control subsystem 134 may control the exhaust treatment
system, for which purpose it detects the corresponding sensor
signals. Second control subsystem 134 also exchanges signals
10   with first control subsystem 132, including those relating to
injected fuel volume ME. Both control systems may make mutual
use of the sensor signals and internal signals.

The first control subsystem, which is also referred to as
15   engine controller 132, controls control signal AD for
controlling fuel metering unit 140 as a function of various
signals that characterize the operating state of fuel
injection system 100, the status of fuel metering system 140
and the ambient conditions, as well as a signal that
20   characterizes the desired power output and/or torque. Devices
of this type are conventional and are used in many different
applications.

In the case of diesel-powered internal combustion engines,
25   particle emissions may occur in the exhaust gas. In this case,
exhaust treatment unit 110 must filter these particles out of
the exhaust gas. This filtering action causes particles to
collect in filter 114. To clean the filter, these particles
are then burned in certain operating states and/or at the end
30   of certain time periods. For this purpose, the temperature in
exhaust treatment unit 110 is usually increased to the point
at which the particles combust, thus regenerating filter 114.

Primary catalytic converter 112 is provided to increase the
35   temperature. For example, the temperature is increased by
increasing the proportion of uncombusted hydrocarbons in the
exhaust gas. These uncombusted hydrocarbons then react in

primary catalytic converter 112, thereby increasing its temperature and thus also the temperature of the exhaust gas that enters filter 114.

5   Increasing the temperature of the primary catalytic converter and exhaust gas in this manner increases fuel consumption and should therefore be carried out only when necessary, i.e., when a certain volume of particles has accumulated in filter 114. One way to detect the state of congestion is to measure
10   differential pressure DP between the inlet and outlet of the exhaust treatment unit 110 and to determine the state of congestion based on this value. Differential-pressure sensor 120 is provided for this purpose.

15   According to the present invention, the anticipated particle emissions are determined on the basis of different quantities, such as speed N and injected fuel volume ME, thereby simulating the state of congestion. Once a specific state of congestion has been reached, filter 114 is regenerated by
20   controlling fuel metering unit 140. Instead of speed N and injected fuel volume ME, other signals that characterize these quantities may also be used. For example, a control signal, such as a control duration for the injectors and/or a torque quantity, may be used as fuel volume ME.
25

In one example embodiment according to the present invention, in addition to injected fuel volume ME and speed N, temperature T in the exhaust treatment system may be used to calculate the state of congestion. Sensor 124 may be used for
30   this purpose. The quantity for the state of congestion calculated in this manner is then used to control the exhaust treatment system, i.e., regeneration is initiated by increasing the temperature, as a function of the state of congestion.
35

The state of congestion may be measured via differential-pressure sensor 120 in addition to calculating the state of

congestion. In this case, the system may be monitored for errors. Simulated quantity B and measured quantity BI of the state of congestion may be used to detect errors in the exhaust treatment system. When an error in differential-

5   pressure sensor 120 is detected, an emergency mode may be implemented to control the exhaust treatment system, using the simulated quantity that characterizes the state of congestion.

Figure 2 is a block diagram illustrating a method and a device

10   for detecting the state of congestion, i.e., quantity B, which characterizes the status of the exhaust treatment system, according to the present invention. Elements already described in Figure 1 are identified by the same reference numbers.

15

Output signals N of a speed sensor 152, a quantity ME of fuel metering controller 136, which characterizes the injected fuel volume, and/or a quantity characterizing the oxygen concentration, are supplied to a basic characteristic map 200.

20   The quantity characterizing the oxygen concentration may be measured by a sensor or determined by a calculation 125.

Basic characteristic map 200 applies a quantity GR, which characterizes the initial value of the particle emission, to a

25   first node 205. First node 205 applies a signal to a second node 210, which, in turn, applies a quantity KR, which characterizes particle increment in filter 114, to an integrator 220. Integrator 220 supplies a quantity B, which characterizes the status of the exhaust treatment system. This

30   quantity B corresponds to the state of congestion of filter 114. Quantity B is provided to control system 130.

The output signal of a first adjustment element 230, to which is supplied the output signal of different sensors 235, is

35   present at the second input of node 205. Sensors 235 supply signals that characterize the ambient conditions. These include cooling water temperature TW, air temperature and air

NY01 417103 v 2   6   **SUBSTITUTE SPECIFICATION**

pressure PL. The output signal of a second adjustment element 240 is supplied to the second input of node 210 via a switching unit 245. Output signal T of sensor 124 is supplied to second adjustment element 240. Alternatively, the output

5 signal of a default-value generator 249 may also be supplied to the second input of second node 210 via switching unit 245. Switching unit 245 is controlled by an error detector 248.

The oxygen concentration in the exhaust gas may be influenced
10 with a further adjustment, corresponding to adjustment element 230.

Initial value GR of particle emission is stored in basic characteristic map 200 as a function of the operating state of
15 the internal combustion engine, such as speed N, injected volume ME and/or the quantity characterizing the oxygen concentration. For example, speed N and the quantity characterizing the oxygen concentration may be used, or speed N and injected volume ME may be used.
20
Other quantities may also be used in addition to these quantities. Instead of volume ME, a quantity that characterizes the volume of injected fuel may be used.

25 This value is adjusted in first node 205 as a function of a temperature of the cooling water and ambient air as well as atmospheric pressure. This adjustment takes into account their influence on the particle emission of internal combustion engine 100.
30
The influence of the catalytic converter temperature is taken into account in second node 210. The adjustment takes into account the fact that, above a certain temperature T1, the particles are not deposited in the filter but are directly
35 converted to harmless components. Below this temperature T1, the particles are not converted, but are all deposited in the filter.

As a function of temperature T of exhaust treatment unit 110, second adjustment element 240 sets a factor F by which basic emission GR may be multiplied.

5   Figure 3 illustrates the correlation between factor F and temperature T. Up to temperature T1, factor F assumes a value of 1. Thus, below temperature T1, initial value GR is linked to factor F in node 210 so that value KR is equal to value GR. Above temperature T1, factor F decreases and reaches a value

10   of zero at a certain temperature T2, i.e., the entire particle emission is converted directly to harmless components, thereby supplying no additional particles to filter 114. If the temperature exceeds value T3, the factor assumes a negative value of x, indicating a decrease in congestion of filter 114,

15   even though particles are being supplied to filter 114.

If error detector 248 detects a defective temperature sensor T24, a default value from default-value generator 249 is used instead of temperature value T. This default value may be set

20   as a function of different operating parameters, such as injected fuel volume ME.

Value KR, which has been adjusted in this manner and characterizes the particle value resulting in congestion of

25   filter 114, is supplied to integrator 220. This integrator 220 sums up the quantity over time and emits a signal B that characterizes the state of congestion of filter 114. The adjusted output signal of the basic characteristic map is integrated to determine state of congestion B of filter 114.

30

Signal B, which characterizes the state of congestion of filter 114, may be used directly to control the exhaust treatment system. The use of a simulated quantity eliminates the need for various sensors, including differential-pressure

35   sensor 120.

According to the present invention, the state of congestion is output from a characteristic map, based on at least the speed and/or the injected fuel volume or corresponding signals. The initial value determined in this manner is then adjusted. For example, it may be adjusted as a function of the temperature of the exhaust treatment unit, such as that of the particle filter. This adjustment takes into account continuous, temperature-dependent filter regeneration.

Figure 4 illustrates another example embodiment. Reference number 400 designates the simulation element illustrated in Figure 2 to calculate state of congestion B. This simulation element 400 supplies a signal B for the state of congestion of filter 114. A further calculation element 420 is provided, to which output signal DP of differential-pressure sensor 120 is supplied. Both simulation element 400 and calculation element 420 supply signals to a switching unit 410, which selects one or another of the signals and provides it to control system 130. Switching unit 410 is controlled by an error detector 415.

Based on differential pressure DP, which is measured by differential-pressure sensor 120, air flow rate V may be calculated according to the following formula:

$$V = \frac{MH * R * T}{P + DP}$$

where quantity MH corresponds to the air rate measured by a sensor, while quantity R is a constant. Based on the air flow rate calculated in this manner, a characteristic map may be used to calculate state of congestion BI.

The exhaust treatment system is controlled during normal operation based on this state of congestion BI. If an error occurs in the exhaust treatment system, for example, when

NY01 417103 v 2   9   **SUBSTITUTE SPECIFICATION**

detecting or recording differential pressure DP, error
detector 415 controls switching unit 410 so that signal B of
simulation element 400 is used to control the exhaust
treatment system.

5

In emergency mode, quantity (B) is used to control the exhaust
treatment system. The system is controlled as a function of
quantity (B), which characterizes the state of congestion,
and/or additional signals. The simulated quantity may be used
10 to implement a very accurate emergency mode. When used only in
emergency mode, a simple simulation using only a few signals
may be used.

The plausibility of calculated quantity (BI) and simulated
15 quantity (B) of the state of congestion may be checked and an
error in the exhaust treatment system in the event of
implausibility may be detected. Implausibility is detected,
for example, when the difference between the two quantities is
greater than a threshold value. This means that quantity (B)
20 of the state of congestion is used to detect the error. This
procedure is a simple and accurate error detection method.

ABSTRACT

In a method and device for controlling an internal combustion engine having an exhaust treatment system, a quantity characterizing the status of the exhaust treatment system is

5   determined on the basis of at least one operating parameter of the internal combustion engine.

3/PRTS

DEVICE AND METHOD FOR CONTROLLING AN INTERNAL COMBUSTION ENGINE HAVING AN EXHAUST TREATMENT SYSTEM

Background Information

5   The present invention relates to a method and a device for controlling an internal combustion engine having an exhaust treatment system.

       A method and a device for controlling an internal combustion engine having an exhaust treatment system is known from non-prior art German Patent No. 199 06 287. The system described
10   in this document uses a particle filter that filters out particles contained in the exhaust gas. To precisely control an internal combustion engine having an exhaust treatment system, the status of the exhaust treatment system must be known. In particular, the filter's state of congestion, i.e.,
15   the volume of filtered-out particles, must be known.

Object of the Invention

       In conjunction with a method and a device for controlling an
20   internal combustion engine having an exhaust treatment system, the object of the present invention is to provide a method and a device that can be used to detect the status of the exhaust treatment system. In particular, the state of congestion must be detected even when different sensors fail or when no
25   special sensors are used.

       This object is achieved by the features described in the independent claims.

30

NY01 417060 v 1

Advantages of the Invention

The method according to the present invention makes it
possible to easily detect the status of the exhaust treatment

5   system. Simulating the quantity that characterizes the status
of the exhaust treatment system, based on at least one
operating parameter of the internal combustion engine,
eliminates the need for additional sensors. If additional
sensors are used, they can be monitored and an emergency mode

10   implemented. It is particularly advantageous that only those
quantities are used for the simulation that are already being
used to control the internal combustion engine.

It is particularly advantageous to use a quantity that

15   characterizes the oxygen concentration in the exhaust gas.
This can significantly improve the simulation of the status of
the exhaust treatment system. This applies, in particular, to
dynamic states, i.e., more accurate values can be achieved,
particularly during acceleration.

20
Further especially advantageous embodiments are described in
the subordinate claims.

Drawing

25
The present invention is explained below on the basis of the
embodiments illustrated in the drawing. Figure 1 shows a block
diagram of the device according to the present invention;
Figure 2 shows a detailed representation of the simulation;

30   Figure 3 shows a characteristic curve; and Figure 4 shows a
further embodiment of the device according to the present
invention.

Description of Exemplary Embodiments

35
The device according to the present invention is described
below, based on the example of an internal combustion engine

having spontaneous ignition in which fuel metering is controlled by a common-rail system. However, the procedure according to the present invention is not limited to these systems. It can also be used with other internal combustion

5 engines.

Reference number 100 designates an internal combustion engine which receives a supply of fresh air via an intake line 102 and discharges exhaust gases via an exhaust line 104. An

10 exhaust treatment means 110, from which the cleaned exhaust gases pass through line 106 to the environment, is provided in exhaust line 104. Exhaust treatment means 110 essentially includes a primary catalytic converter 112 and a downstream filter 114. A temperature sensor 124, which provides a

15 temperature signal T, is preferable located between primary catalytic converter 112 and filter 114. Sensors 120a and 120b are provided upstream from primary catalytic converter 112 and downstream from filter 114, respectively. These sensors act as differential-pressure sensors 120 and provide a differential-

20 pressure signal DP, which characterizes the differential pressure between the inlet and outlet of the exhaust treatment means.

One particularly advantageous embodiment provides a sensor 125

25 that supplies a signal characterizing the oxygen concentration in the exhaust gas. As an alternative or additional feature, this quantity can be calculated on the basis of other measured values or be determined by a simulation.

30 Fuel is supplied to internal combustion engine 100 via a fuel metering unit 140. This unit meters fuel to the individual cylinders of internal combustion engine 100 via injectors 141, 142, 143 and 144. The fuel metering unit is preferably a common rail system. A high-pressure pump delivers fuel to an

35 accumulator. The fuel passes from the accumulator to the internal combustion engine via the injectors.

Various sensors 151, which provide signals that characterize
the status of the fuel metering unit, are attached to fuel
metering unit 140. In the case of a common rail system, these
include, for example, pressure P in the accumulator. Sensors

5   152 that characterize the status of the internal combustion
engine are attached to internal combustion engine 100. These
are preferably a speed sensor that provides a speed signal N
and additional sensors that are not illustrated.

10   The output signals from these sensors are supplied to a
control system 130, which is represented by a first control
subsystem 132 and a second control subsystem 134. The two
control subsystems preferably form a single structural unit.
First control subsystem 132 preferably controls fuel metering

15   unit 140 via control signals AD that influence fuel metering.
For this purpose, first control subsystem 132 includes a fuel
volume controller 136. The latter supplies a signal ME, which
characterizes the volume to be injected, to second control
subsystem 134.

20

Second control subsystem 134 preferably controls the exhaust
treatment system, for which purpose it detects the
corresponding sensor signals. Second control subsystem 134
also exchanges signals with first control subsystem 132, in

25   particular those relating to injected fuel volume ME. Both
control systems preferably make mutual use of the sensor
signals and internal signals.

The first control subsystem, which is also referred to as

30   engine controller 132, controls control signal AD for
controlling fuel metering unit 140 as a function of various
signals that characterize the operating state of fuel
injection system 100, the status of fuel metering system 140
and the ambient conditions, as well as a signal that

35   characterizes the desired power output and/or torque. Devices
of this type are known and used in many different
applications.

Particularly in the case of diesel-powered internal combustion engines, particle emissions can occur in the exhaust gas. In this case, exhaust treatment means 110 must filter these particles out of the exhaust gas. This filtering action causes

5   particles to collect in filter 114. To clean the filter, these particles are then burned in certain operating states and/or at the end of certain time periods. For this purpose, the temperature in exhaust treatment means 110 is usually increased to the point at which the particles combust, thus

10   regenerating filter 114.

Primary catalytic converter 112 is provided to increase the temperature. For example, the temperature is increased by increasing the proportion of uncombusted hydrocarbons in the

15   exhaust gas. These uncombusted hydrocarbons then react in primary catalytic converter 112, thereby increasing its temperature and thus also the temperature of the exhaust gas that enters filter 114.

20   Increasing the temperature of the primary catalytic converter and exhaust gas in this manner increases fuel consumption and should therefore be carried out only when necessary, i.e., when a certain volume of particles has accumulated in filter 114. One way to detect the state of congestion is to measure

25   differential pressure DP between the inlet and outlet of the exhaust treatment means and to determine the state of congestion based on this value. This requires a differential-pressure sensor 120.

30   According to the present invention, the anticipated particle emissions are determined on the basis of different quantities, in particular speed N and injected fuel volume ME, thereby simulating the state of congestion. Once a specific state of congestion has been reached, filter 114 is regenerated by

35   controlling fuel metering unit 140. Instead of speed N and injected fuel volume ME, other signals that characterize these quantities can also be used. For example, the control signal,

in particular the control duration, for the injectors and/or a torque quantity can be used as fuel volume ME.

In one embodiment according to the present invention, not only injected fuel volume ME and speed N, but also temperature T in the exhaust treatment system is used to calculate the state of congestion. Sensor 124 is preferably used for this purpose. The quantity for the state of congestion calculated in this manner is then used to control the exhaust treatment system, i.e., regeneration is initiated by increasing the temperature, as a function of the state of congestion.

It is particularly advantageous to measure the state of congestion via differential-pressure sensor 120 in addition to calculating it. In this case, the system can be monitored for errors. This means using simulated quantity B and measured quantity BI of the state of congestion to detect errors in the exhaust treatment system. When an error in differential-pressure sensor 120 is detected, an emergency mode can be implemented to control the exhaust treatment system, using the simulated quantity that characterizes the state of congestion.

Figure 2 shows a block diagram that illustrates a method and a device for detecting the state of congestion, i.e., quantity B, which characterizes the status of the exhaust treatment system. Elements already described in Figure 1 are identified by the same reference numbers.

Output signals N of a speed sensor 152, a quantity ME of fuel metering controller 136, which characterizes the injected fuel volume, and/or a quantity characterizing the oxygen concentration, are supplied to a basic characteristic map 200. The quantity characterizing the oxygen concentration is preferably specified by a sensor or a calculation 125.

Basic characteristic map 200 applies a quantity GR, which characterizes the initial value of the particle emission, to a

first node 205. First node 205 applies a signal to a second node 210, which, in turn, applies a quantity KR, which characterizes particle increment in filter 114, to an integrator 220. Integrator 220 supplies a quantity B, which

5   characterizes the status of the exhaust treatment system. This quantity B corresponds to the state of congestion of filter 114. Quantity B is provided to control system 130.

The output signal of a first adjustment element 230, to which

10   is supplied the output signal of different sensors 235, is present at the second input of node 205. Sensors 235 supply signals that characterize, in particular, the ambient conditions. These include cooling water temperature TW, air temperature and air pressure PL. The output signal of a second

15   adjustment element 240 is supplied to the second input of node 210 via a switching means 245. Output signal T of sensor 124 is supplied to second adjustment element 240. Alternatively, the output signal of a default-value generator 249 can also be supplied to the second input of second node 210 via switching

20   means 245. Switching means 245 is controlled by an error detector 248.

It is particularly advantageous to influence the oxygen concentration in the exhaust gas with a further adjustment,

25   corresponding to adjustment element 230.

Initial value GR of particle emission is stored in basic characteristic map 200 as a function of the operating state of the internal combustion engine, in particular speed N,

30   injected volume ME and/or the quantity characterizing the oxygen concentration. It is particularly advantageous to use speed N and the quantity characterizing the oxygen concentration. In addition, it is advantageous to use speed N and injected volume ME.

35

Other quantities can also be used in addition to these
quantities. Instead of volume ME, it is possible to use a
quantity that characterizes the volume of injected fuel.

5   This value is adjusted in first node 205 as a function of the
temperature of the cooling water and ambient air as well as
atmospheric pressure. This adjustment takes into account their
influence on the particle emission of internal combustion
engine 100.

10

The influence of the catalytic converter temperature is taken
into account in second node 210. The adjustment takes into
account the fact that, above a certain temperature T1, the
particles are not deposited in the filter but are directly

15   converted to harmless components. Below this temperature T1,
the particles are not converted, but are all deposited in the
filter.

As a function of temperature T of exhaust treatment means 110,

20   second adjustment element 240 sets a factor F by which basic
emission GR is preferably multiplied.

Figure 3 shows the correlation between factor F and
temperature T. Up to temperature T1, factor F assumes a value

25   of 1. This means that, below temperature T1, initial value GR
is linked to factor F in node 210 so that value KR is equal to
value GR. Above temperature T1, factor F decreases and reaches
a value of zero at a certain temperature T2, i.e., the entire
particle emission is converted directly to harmless

30   components, which means that no more particles are supplied to
filter 114. If the temperature exceeds value T3, the factor
assumes a negative value of x. This means that the congestion
in filter 114 decreases even though particles are being
supplied to filter 114.

35

If error detector 248 detects a defective temperature sensor
T24, a default value from default-value generator 249 is used

instead of temperature value T. This default value is preferably also set as a function of different operating parameters, such as injected fuel volume ME.

5   Value KR, which has been adjusted in this manner and characterizes the particle value resulting in congestion of filter 114, is supplied to integrator 220. This integrator 220 sums up the quantity over time and emits a signal B that characterizes the state of congestion of filter 114. The
10   adjusted output signal of the basic characteristic map is integrated to determine state of congestion B of filter 114.

Signal B, which characterizes the state of congestion of filter 114, is normally used directly to control the exhaust
15   treatment system. The use of a simulated quantity eliminates the need for various sensors, particularly for differential-pressure sensor 120.

According to the present invention, the state of congestion is
20   output from a characteristic map, based on at least the speed and/or the injected fuel volume or corresponding signals. The initial value determined in this manner is then adjusted. In particular, it is adjusted as a function of the temperature of the exhaust treatment means, in particular that of the
25   particle filter. This adjustment takes into account continuous, temperature-dependent filter regeneration. Figure 4 shows a further especially advantageous embodiment. Reference number 400 designates the simulation element illustrated in Figure 2 to calculate state of congestion B.
30   This simulation element 400 supplies a signal B for the state of congestion of filter 114. A further calculation element 420 is provided, to which output signal DP of differential-pressure sensor 120 is supplied. Both simulation element 400 and calculation element 420 supply signals to a switching
35   means 410, which selects one or another of the signals and provides it to control system 130. Switching means 410 is controlled by an error detector 415.

Based on differential pressure DP, which is measured by differential-pressure sensor 120, air flow rate V can be calculated according to the following formula:

5
$$V = \frac{MH * R * T}{P + DP}$$

where quantity MH corresponds to the air rate measured by a sensor, while quantity R is a constant. Based on the air flow rate calculated in this manner, a characteristic map can
10   preferably be used to calculate state of congestion BI.

The exhaust treatment system is controlled during normal operation based on this state of congestion BI. If an error occurs in the exhaust treatment system, in particular when
15   detecting or recording differential pressure DP, error detector 415 controls switching means 410 so that signal B of simulation element 400 is used to control the exhaust treatment system.

20   In emergency mode, quantity (B) is used to control the exhaust treatment system. The system is controlled as a function of quantity (B), which characterizes the state of congestion, and/or additional signals. The simulated quantity can be used to implement a very accurate emergency mode. When used only in
25   emergency mode, it is especially advantageous to use a simple simulation with only a few signals.

It is particularly advantageous to check the plausibility of calculated quantity (BI) and simulated quantity (B) of the
30   state of congestion and to detect an error in the exhaust treatment system in the event of implausibility.
Implausibility is detected, for example, when the difference between the two quantities is greater than a threshold value. This means that quantity (B) of the state of congestion is

used to detect the error. This procedure is a simple and accurate error detection method.

Translation of new German Pages 13 and 14

What is claimed is

1. A method for controlling an internal combustion engine having an exhaust treatment system that includes a particle filter, a quantity (B) characterizing the state of congestion of the particle filter being simulated on the basis of at least one operating parameter of the internal combustion engine, wherein a quantity characterizing the oxygen concentration in the exhaust gas and/or the temperature (T) in the exhaust treatment system is used to simulate the quantity (B) characterizing the state of congestion of the particle filter.

2. The method according to Claim 1, wherein the quantity (B) characterizing the state of congestion of the particle filter is simulated on the basis of at least the rotational speed (N) and/or a signal (ME) characterizing the injected fuel volume.

3. The method according to Claim 1, wherein the quantity characterizing the oxygen concentration in the exhaust gas is determined on the basis of operating parameters.

4. The method according to one of the preceding claims, wherein the quantity (B) characterizing the state of congestion of the particle filter is used to control the exhaust treatment system during normal operation.

5. The method according to one of the preceding claims, wherein the quantity (B) characterizing the state of congestion of the particle filter is used to detect an error.

6. The method according to one of the preceding claims, **ART 34 AMDT**

wherein the quantity (B) characterizing the state of congestion of
the particle filter is used to control the exhaust treatment
system during emergency operation.

7. A device for controlling an internal combustion engine having
an exhaust treatment system that includes a particle filter,
having means that simulate a quantity (B) characterizing the state
of congestion of the particle filter on the basis of at least one
operating parameter of the internal combustion engine,
wherein the means use a quantity characterizing the oxygen
concentration in the exhaust gas and/or the temperature (T) in the
exhaust treatment system to simulate the quantity (B)
characterizing the state of congestion of the particle filter.

Abstract

Method and device for controlling an internal combustion
engine having an exhaust treatment system. A quantity (B)
5   characterizing the status of the exhaust treatment system is
determined on the basis of at least one operating parameter of
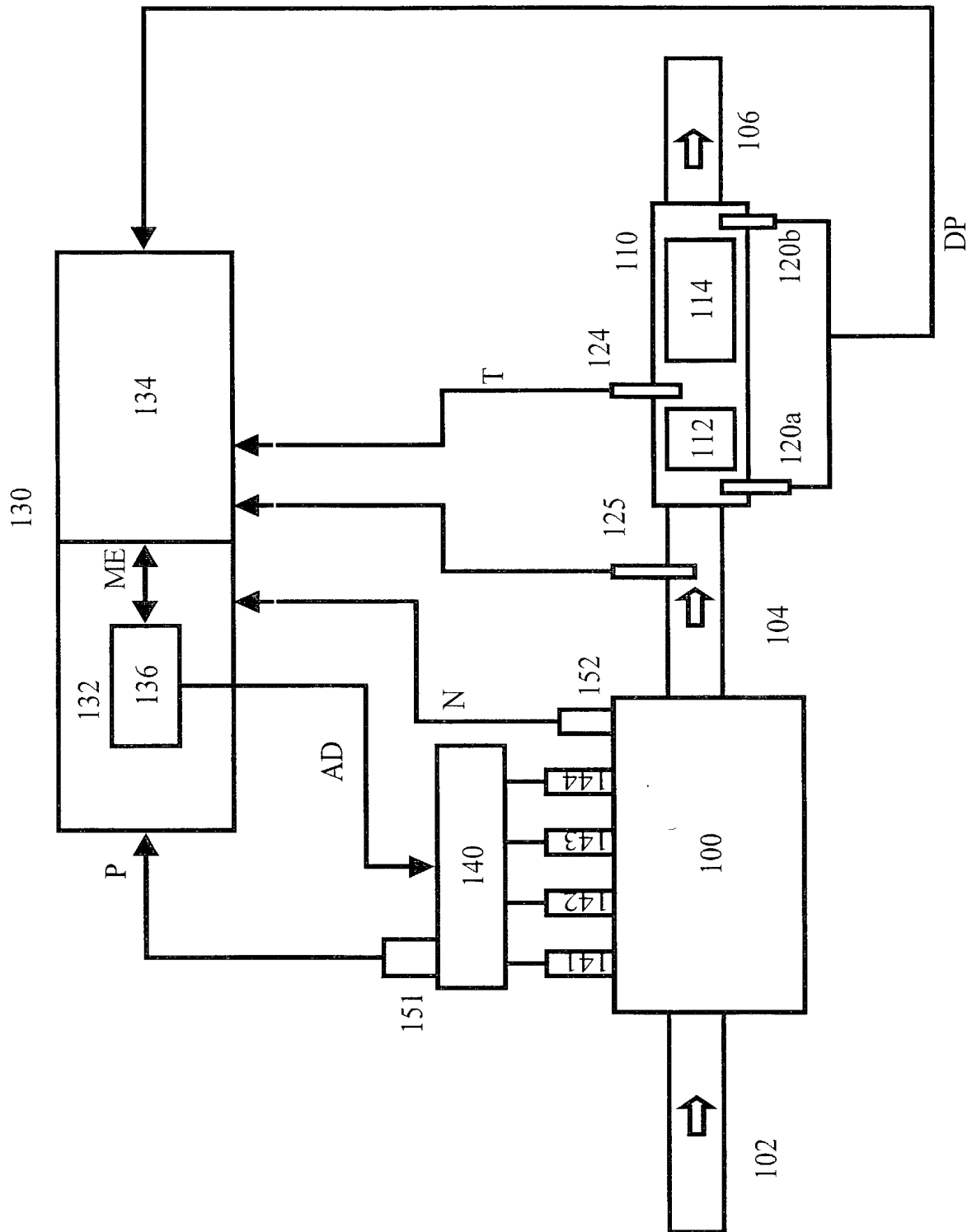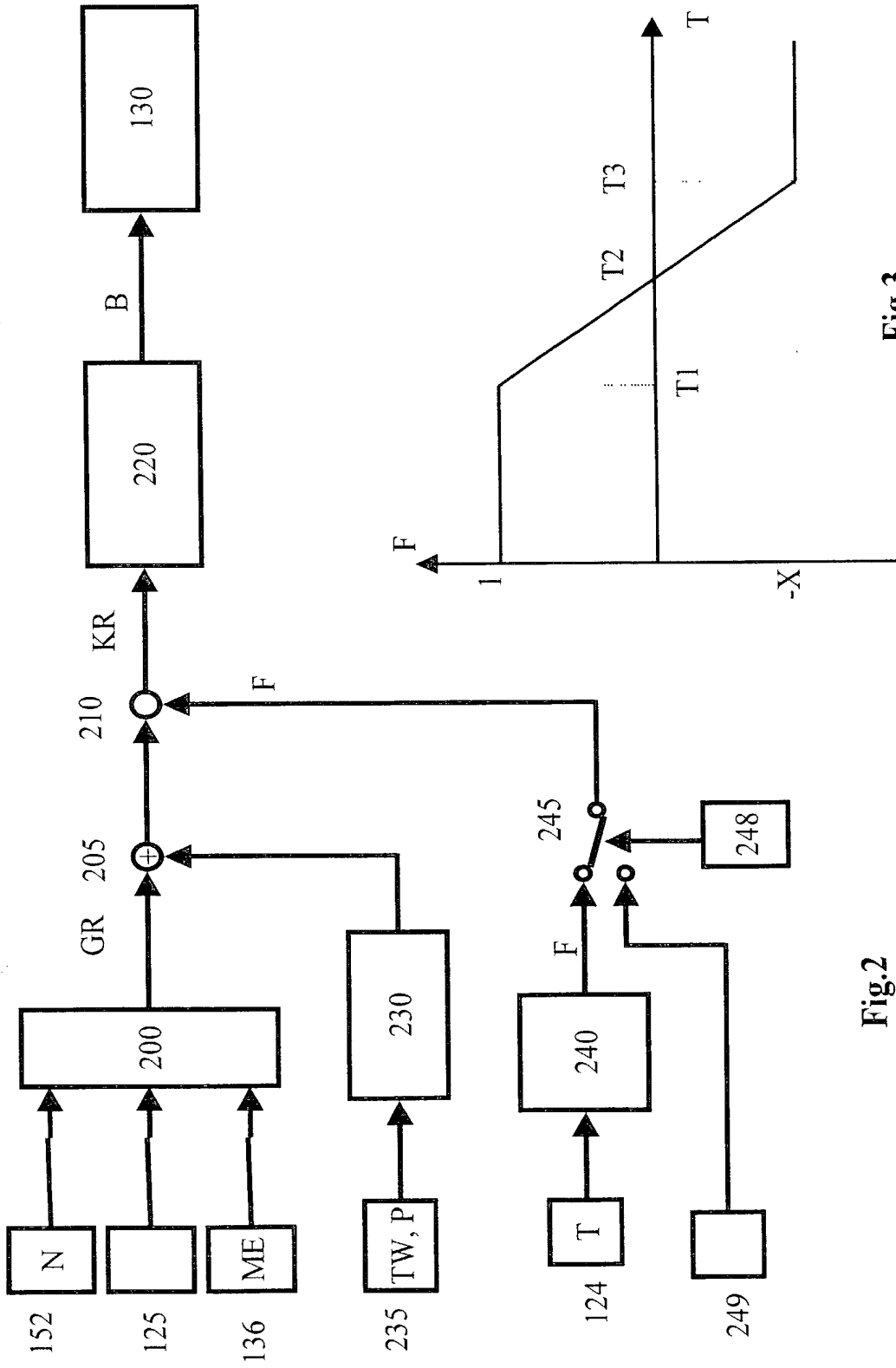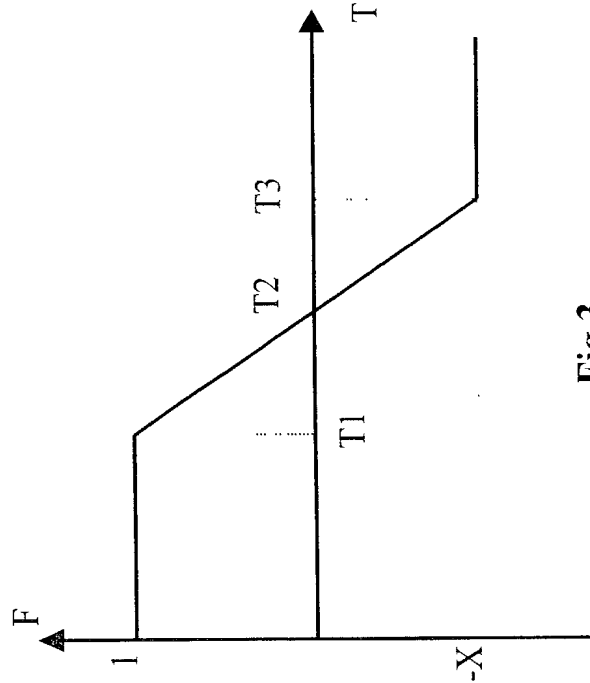the internal combustion engine.

(Figure)

Fig.1

Fig.2

Fig.3
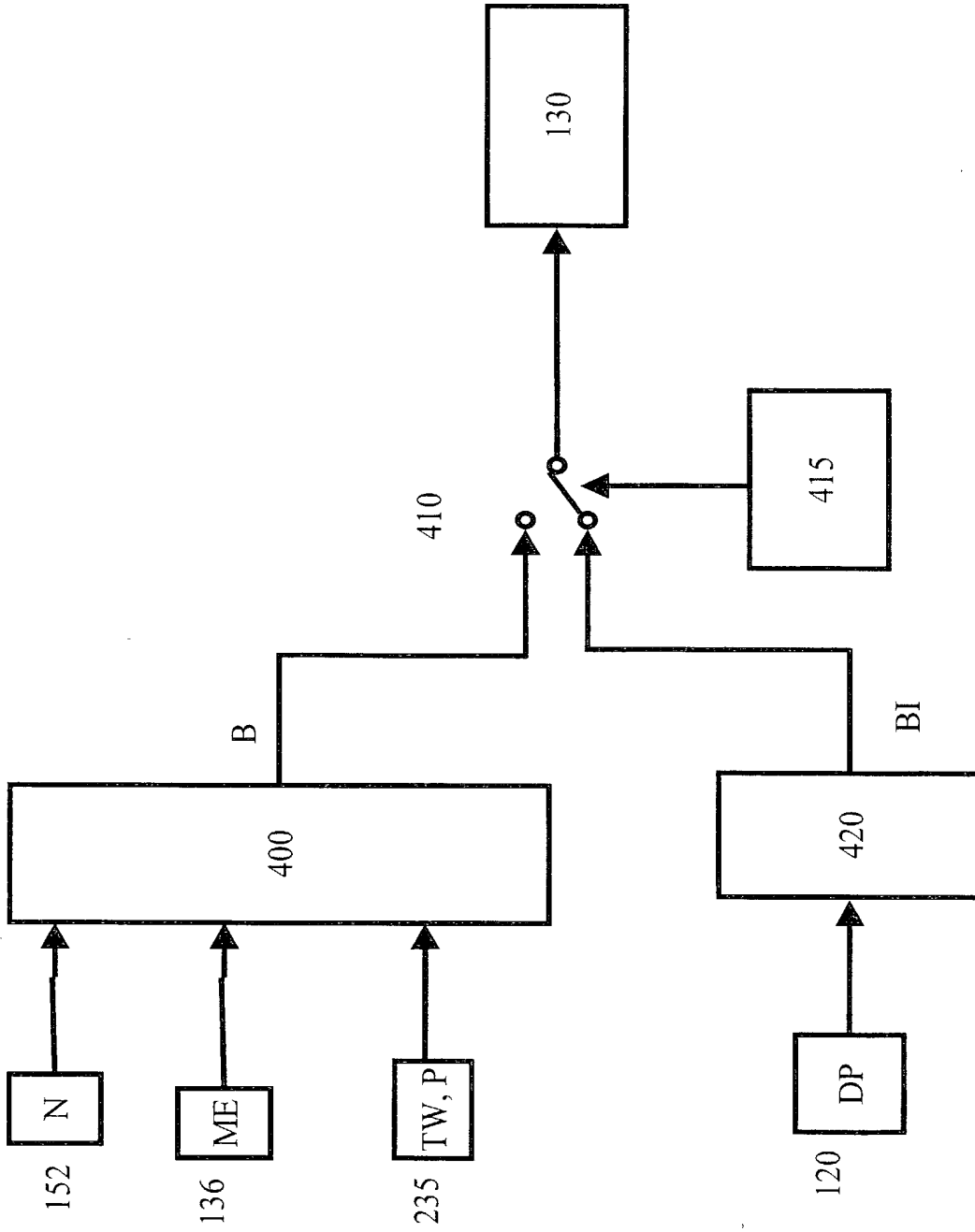
Fig.4

<u>DECLARATION AND POWER OF ATTORNEY</u>

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am an original, first and joint inventor of the subject matter which is claimed and for which a patent is sought on the invention entitled **DEVICE AND METHOD FOR CONTROLLING AN INTERNAL COMBUSTION ENGINE HAVING AN EXHAUST TREATMENT SYSTEM**, the specification of which was filed as International Application No. PCT/DE00/01322 on April 27, 2000.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, § 1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application(s) for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

<u>PRIOR FOREIGN APPLICATION(S)</u>

Number	Country Filed	Day/Month/Year	Priority Claimed Under 35 USC 119
199 21 299.6	Fed. Rep. of Germany	7 May 1999	Yes
100 14 224.9	Fed. Rep. of Germany	22 March 2000	Yes

And I hereby appoint Richard L. Mayer (Reg. No. 22,490) and

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I hereby declare that all statements made herein of my own knowledge are true

and that all statements made on information and belief are believed to be true; and further that

these statements were made with the knowledge that willful false statements and the like so

made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the

United States Code and that such willful and false statements may jeopardize the validity of

the application or any patent issued thereon.

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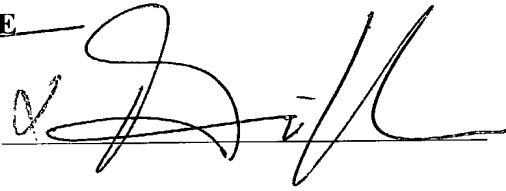
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